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KatAWARE THE GAME

A ROLE-PLAYING GAME TO SUPPORT LOCAL MULTI-STAKEHOLDER NEGOTIATIONS AROUND WATER MANAGEMENT IN THE KAT RIVER VALLEY

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A STAKEHOLDER DRIVEN PROCESS TO DEVELOP A CATCHMENT MANAGEMENT PLAN FOR THE KAT RIVER VALLEY

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Terminology and Acronyms

KatAWARE	The Multi-Agent model developed in the Kat River Catchment
DWAF	Department of Water Affairs and Forestry
IWR	Institute for Water Research
LS	Lower Sub-Catchment
MS	Middle Sub-Catchment
MT	Modelling Team
RPG	Role-Playing Game
ST	Social Team
US	Upper Sub-Catchment
WRC	Water Research Commission
WUA	Water User Association

PREFACE

This report illustrates a Role Playing Game (RPG), which is being developed within the Water Research Commission (WRC) project “A stakeholder driven process to develop a Catchment Management Plan for the Kat River Valley”, hereafter quoted as “the Kat River project”.

The RPG is called KatAWARE, like the multi-agent model (Farolfi-Bonté, 2005 and 2006) that backs it. The RPG is being developed within an iterative and participatory process called Companion Modelling – ComMod (Farolfi and Rowntree, 2005) aiming at co-constructing the multi-agent model KatAWARE and at the same time facilitating discussions and common decision-making around water management within the Kat River Water Users Association (WUA).

The report is organized in four main chapters: the first chapter illustrates the position of the RPG in the ComMod process and its relations with the KatAWARE model; the second chapter looks at the main features of the RPG; the third chapter presents some outcomes of the first RPG session played at Fort Beaufort in November 2005; the last chapter concludes and defines the way forward.

1. THE ROLE-PLAYING GAME AND ITS POSITION WITHIN THE COMMOD PROCESS

1.1 The development question

The RPG, as the KatAWARE model aims at answering the following development question: "How to improve local water management in the Kat Valley through a better stakeholders participation and a more democratic decision-making process?". The RPG should allow local stakeholders (the WUA) better understanding the KatAWARE model and, meanwhile, discussing strategies for water allocation over a period corresponding to two water business plans (5+5 years).

The introduction of the RPG within the ComMod process adopted in the Kat River Project was strongly suggested by the "Social Team" of the Rhodes University research Group (Burt et al., 2005a). They indicated the RPG as a useful tool to add concreteness to the ComMod process of co-construction of the KatAWARE model with the WUA.

1.2 Objectives of the RPG

a) Improve researchers' knowledge on the local stakeholders' decision-making and negotiation processes and practices.
b) Improve local stakeholders' knowledge on the possible consequences of the adoption of alternative water allocation and management strategies in a context of multi-sector uses of the resource; improve knowledge on the water system complexity at the catchment level; reduce asymmetry of information, increasing equity and transparency and enhancing efficiency in the decision-making process.
c) Empower local stakeholders in their capacity of decision-making and negotiating.

1.3 How knowledge and information was introduced into the RPG

The RPG was constructed after the Prototype (Farolfi and Bonté, 2005) and V1 (Farolfi and Bonté, 2006) of the KatAWARE model were developed. As a consequence, all information and data available for the construction of the KAtAWARE model were used and mobilised for the RPG.

1.4 Relation between the RPG and the reality at the conceptualising stage

The RPG formalises a simplified explicit reality. The schematised Kat River Catchment is represented in the RPG space (Figure 1, cf. also next section) and the players are real stakeholders that face environmental and socio-economic parameters "real" as much as possible, and modified only to make the game "playable". The catchment representation in the RPG is a direct derivation of the catchment representation in the KatAWARE model V1 and was legitimated and approved by all players during the first session played at Fort Beaufort in November 2005.

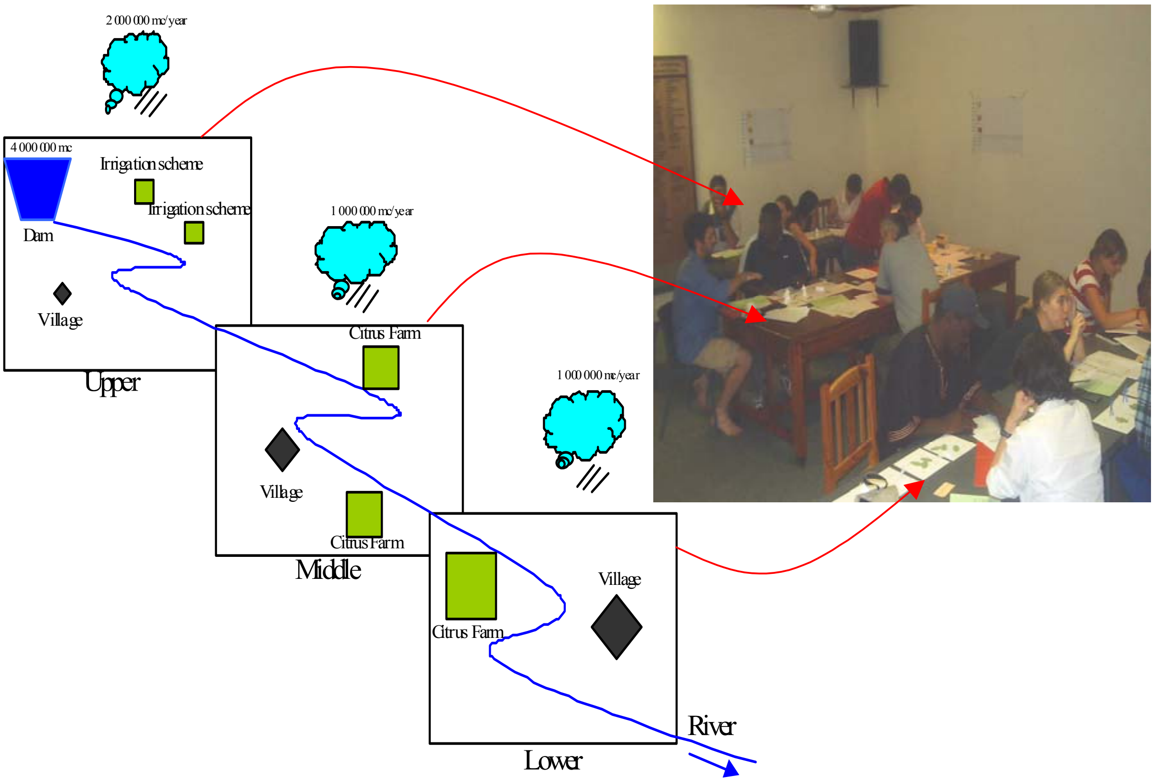

Figure 1 - The "playground" in KatAWARE RPG: schematised catchment and its translation into a RPG session

2. GAME DESCRIPTION

This chapter illustrates the rules and functioning of the RPG through the game explanation provided to each player at the beginning of the RPG session. Some elements of RPG analysis and facilitation are provided at the end of this section.

2.1 The context

The water catchment where you leave and work (Figure 1) is divided into three sub-catchments: Upper, Middle and Lower. Two smallholding irrigation schemes (20 ha each) are located in the Upper Sub-catchment (US), two citrus farms (30 ha each) are located in the Middle Sub-catchment (MS) and one citrus farm (40 ha) is in the Lower Sub-catchment (LS).

Domestic water users live in three villages: one in the US (3 000 hab), one in the MS (5 000 hab) and one (15 000 hab) in the LS.

An average amount of water of 2 million mc/year falls in the US, whilst annual waterfall corresponds to 1 million mc/year in the MS and LS.

A dam with a storage capacity of 4 million mc is located in the US.

A Water Users Association (WUA) exists in the catchment and is responsible for water management and allocation according to the principles of Social Equity, Environmental Sustainability and Economic Efficiency as indicated in the Water Legislation of South Africa. All players are members of the WUA.

2.2 Goals

The primary goal is for your group as a whole to manage in a sustainable way your available water resource, taking into consideration the above-mentioned principles. The secondary goal is for each player (or team of players) to maximise your individual economic gain and if you are a village manager to maximise villagers' satisfaction, within the context of the group goal.

2.3 The players

Five farming players (two smallholding farmers representing an irrigation scheme each and three large scale citrus farmers) are part of the game.

Three players impersonate the local public managers responsible for water provision to domestic users in the three villages.

All players are members of the local WUA and elect a president, which will call annual WUA's meetings. The WUA is managing the dam upstream the catchment and decides water releases as well as water allocations and prices for each sector.

A banker is responsible for money distribution and takes records of each players possible debt.

The game operator is neutral and will provide the players with the results of their chosen water allocation scenarios.

2.4 Resources, initial state and production choices

If you are a Farmer:

You have a surface irrigated on which you produce Cabbages if you are a smallholder or Citrus if you are a large-scale farmer.

At the beginning of the game you will receive a number of hectares corresponding to your farm (or irrigation scheme) and for each ha a symbol corresponding to your production: Cabbage or Citrus.

You will also receive an amount of money corresponding to your previous year's profit and a n. of workers indicating how many permanent and seasonal employees you had the previous season.

Every year you may decide to increase or reduce your irrigated surface. You can decide to change your production (cabbage to citrus or vice versa). If you decide to plant new citrus, you can choose an innovative irrigation technology (drip), which would cost more but will save water.

Cabbage producers can decide to have 1 cycle, 2 cycles or 3 cycles of cabbage production per year on their fields.

Budgets and water consumption data for Citrus and Cabbage are provided to farmers at the beginning of the game.

If you are a local public manager in a village:

You receive, and pay for, bulk water from the WUA that manages the entire water in the catchment. You also provide water services (including water distribution) to the households of your village.

You start with a given ratio of water sources for the households of your village. These water sources are: river water; collective tap; indwelling tap. Each water source implies a different cost for you (investment + operating cost) in addition to the cost of the bulk water you "buy" from the WUA.

You can charge your habitants with a per capita tariff for the water services you provide, and this corresponds to your annual income.

The households of your village get a certain level of satisfaction from their income that they can spend buying consumption goods. They also get different levels of satisfaction from the three sources of water they dispose of.

You have a double objective: 1) maximise your households' satisfaction providing them the best possible water sources; 2) make your budget sustainable, which means balance your cost for water provision with the income you can get from the water charges paid by households.

Elements of budgets and satisfaction indexes for households are provided to local public managers at the beginning of the game.

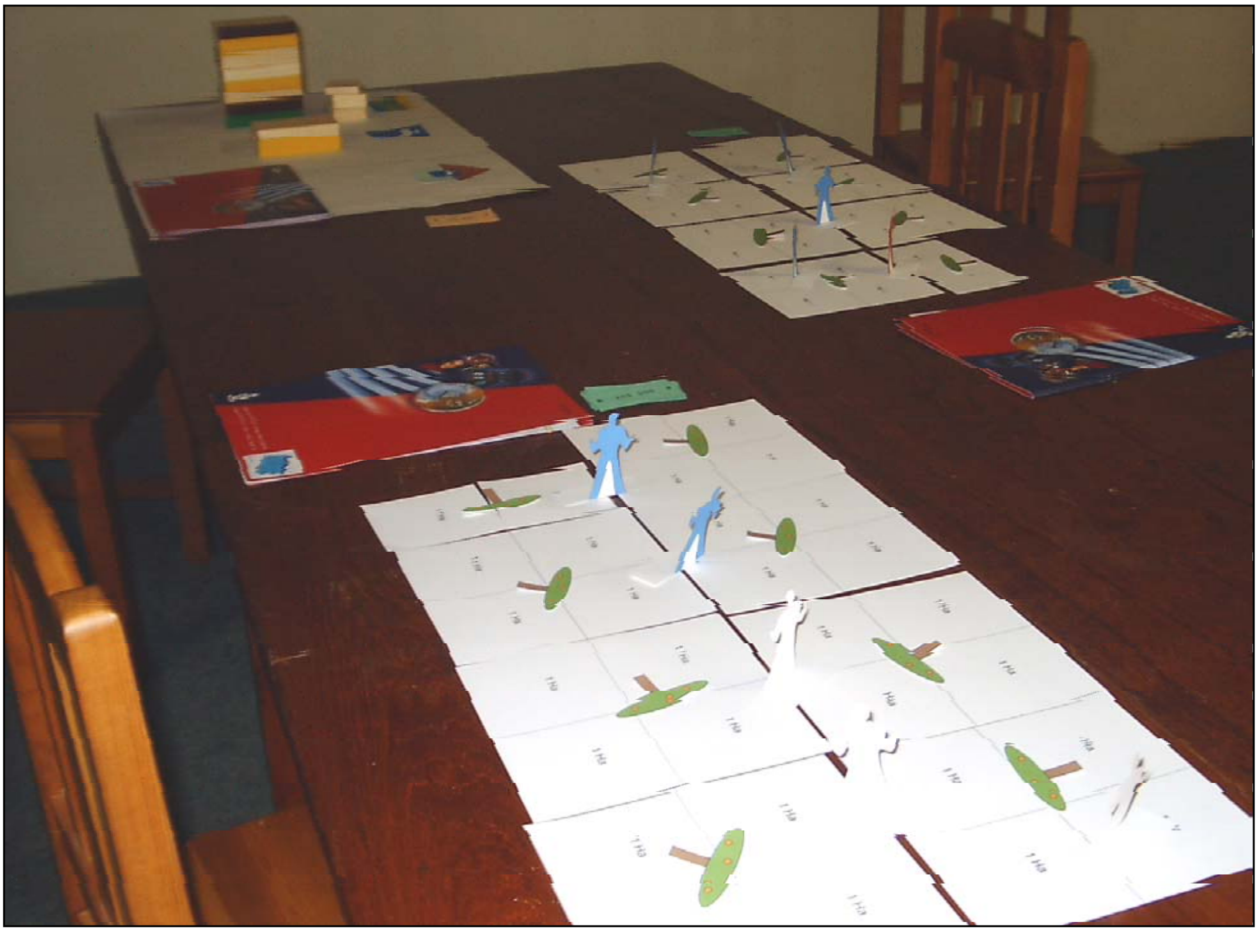

Figure 2 – Two farms and a village in the RPG

2.5 Water management at the catchment level

At the beginning of every year, each player defines individually his strategy for the season to come. Then the WUA President calls a meeting and all players negotiate about water demands in function of water availability in the catchment. The WUA disposes of a model that provides simulations over a year and for each sub-catchment on monthly water availability (including the water storage in the dam), water demands, and possible water deficits to be avoided through water releases from the dam. Water deficits result in a dry river, which corresponds to a non-respect of the ecological Reserve.

Running the model, the WUA can decide to accept or not the players' proposals for the year (which correspond to a water allocation strategy) and the consequent dam management (water releases for the three sub-catchments). WUA finally decides water prices to be paid by the different players.

2.6 Environmental and market (exogenous) factors

Players strategies can be influenced by a number of factors varying annually. These factors depend on external dynamics. Players are informed about exogenous factors at the beginning of each year. These factors include environmental data: Annual rainfall foreseen in US, MS and LS; market data: Citrus and Cabbage prices; and demographic data: population in the three villages of the catchment.

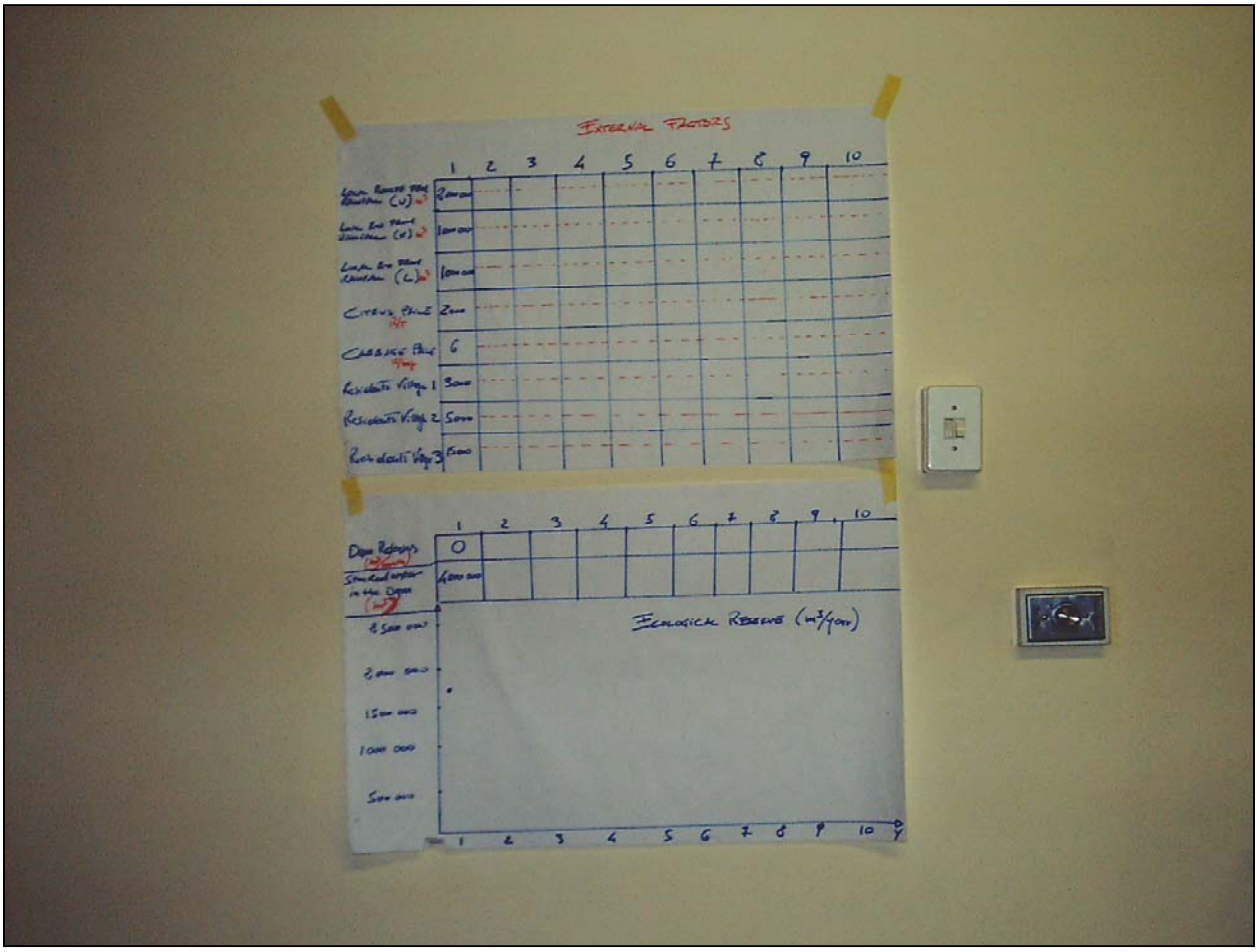

Figure 3 – Posters indicating exogenous factors and dam management

2.7 Decision sheets and players performance criteria

You will draw up a decision sheet, where every year you input your choices as indicated in the point 2.4). An example of decision sheets for farmers and for village water managers is provided hereafter (2.9). Before you finalise your decision sheet, you will have opportunities to discuss your requirements with the WUA and to negotiate with other individual players. Once your annual strategy is cleared by the WUA, your decision sheet is passed to the game operator, who puts this information into the KatAWARE RPG model.

The economic and social results of your choices and WUA strategies, together with the state of the resource, are made available yearly and at the end of each year your financial situation as well as your job-creation (if you are a farmer) or your households' satisfaction (if you are a water provider in a village) are updated.

2.8 Game steps

Every year, all players accomplish the following steps:

1. Receive the results from the computer updating their situation in terms of: cultivated surfaces; profit; employees; households' satisfaction.
2. Receive the updated information about water availability, market prices, and demographic dynamics in the catchment (exogenous factors).
3. Make their choice regarding surfaces, productions, irrigation technology, households' water sources and water price of domestic users for next year (decision sheets).
4. WUA discusses the strategies and takes a decision on: a) water price for each group of stakeholders; b) water releases from the dam; c) acceptation or not of the players' proposals. For this phase, the WUA uses a model that simulates a one-year water demand and supply in the catchment according to the exogenous factors and the players' proposals.
5. Once WUA has cleared all proposals, players fill definitively their decision sheet and provide it to the game operator.

2.9 How the Decision Sheets look

Farmer (Cabbage)

FARM 1

YEAR	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
ANNUAL CROPS PLANTED EVERY YEAR										
Cabbage 1 cycle (HA)										
Cabbage 2 cycles (HA)	20									
Cabbage 3 cycles (HA)										
TOTAL CABBAGE (HA)	20									
CITRUS TREES STAY IN THE GROUND YEAR AFTER YEAR										
New citrus old technology (HA)										
New citrus new technology (HA)										
Citrus pulled out (HA)										
TOTAL CITRUS (HA)	0									

Farmer (Citrus)

FARM 3

YEAR	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
ANNUAL CROPS PLANTED EVERY YEAR										
Cabbage 1 cycle (HA)										
Cabbage 2 cycles (HA)	0									
Cabbage 3 cycles (HA)										
TOTAL CABBAGE (HA)	0									
CITRUS TREES STAY IN THE GROUND YEAR AFTER YEAR										
New citrus old technology (HA)	30									
New citrus new technology (HA)										
Citrus pulled out (HA)										
TOTAL CITRUS (HA)	30									

Village

VILLAGE 1

YEAR	1	2	3	4	5	6	7	8	9	10
Proportion River (0 to 1)	0.8									
Proportion Collective (0 to 1)	0.2									
Proportion Indwelling (0 to 1)	0									
Price water (R/mc)	1									

2.10 Facilitation and analysis of a RPG session

The game session in November 2005 was jointly facilitated by the modelling team (MT) (JP Muller and S Farolfi) and 8 researchers/students from the social team (ST) of the Kat River Project at Rhodes University.

The following functions were delegated to the two facilitating groups.

- Participants (players) convocation (ST)
- Rules explanation-briefing (MT+ST)
- Roles distribution (ST+Players)
- Players' companion during the RPG session (ST)
- Check for time and rules respect (MT+ST)
- Assure the "funny side" of the session (ST)
- Observe behaviour (MT+ST)
- Actions and practices record (MT)
- Facilitating discussions (MT+ST)

The RPG session analysis was organised as follows:

The analysed elements are mainly players' individual and collectives actions (choices). The computer can systematically record the consequences of these choices, such as economic gains/losses, job creation/loss, used/available water, ecological state of the river etc. Other elements regarding players' behaviour, routine/tension moments during the session, can also be analysed through a videotape that recorded the whole session.

A first debriefing was done just after the session in November. A second one, more complete (cf. following section) will be implemented before the next session in March.

3. OUTCOMES OF THE FIRST RPG SESSION (FORT BEAUFORT, NOVEMBER 2005)

This section illustrates some outcomes of a RPG session held in the Kat River in November 2005. The set-up of the game is indicated in figure 1 and included two irrigation schemes and a village in the US, two large scale farmers and a village in the MS, and a large scale farmer and a village in the LS.

The initial values characterizing each player are indicated in the left column of table 2, which also includes final values (end of year 6 of the session) providing an indication of the strategies and trends followed by players during the RPG session.

Table 1 shows the initial and final values of the exogenous factors controlled by the game operators. The game facilitators introduced a general trend of increasing water scarcity. This stress was produced by a combination of lower rainfall and increasing population in the catchment. Some marginal changes (mainly reductions) affected crop prices. A relatively low level of uncertainty was introduced in the session, corresponding to a small difference between expected (forecasted) and actual exogenous factors to which stakeholders were confronted.

	Initial	**Final**	**Difference %**
Rainfall Upper (m3)	2,000,000	1,400,000	*-30*
Rainfall Middle (m3)	1,000,000	600,000	*-40*
Rainfall Lower (m3)	1,000,000	600,000	*-40*
Population Upper (hab.)	3,000	3,500	*17*
Population Middle (hab.)	5,000	5,500	*10*
Population Lower (hab.)	15,000	16,000	*7*
Market Price Citrus (R/ton)	2,000	2,000	*0*
Market Price Cabbage (R/bag)	6	5	*-17*

Table 1 – Exogenous factors in the RPG session: initial and final values

During the session, players in the three sub-catchments opted first for strategies demanding an increasing amount of water (Fig. 4), and then they were obliged to contract their consumption due to an excessive use of water from the dam, its consequent lowering level of water stored (Fig. 5) and the decision by the WUA to stop the water flushes during the final year of the RPG session.

Clear differences in behaviour and strategies among players were observed for different sectors and in the three sub-catchments (tables 2 and 3).

In the US the two irrigation schemes opted first for an intensification of their cabbage productions (from 2 to 3 cycles per year). Only at the end of the RPG session the second irrigation scheme decided to reduce the cultivated surface by 50%.

In the MS, the two citrus farmers adopted two very different strategies, the one oriented first towards diversification (cabbage in addition to citrus) and then abandoning citrus, whilst the other one kept constant the citrus surface but also planted an equivalent surface at cabbage.

In the LS, the large citrus farm adopted a quite “conservative” strategy consisting in reducing only by 25% the planted surface at citrus and not moving to cabbage.

All new citrus plants in the three farms were equipped with innovative irrigation technologies, consisting in drip systems, more costly in terms of investment, but water saving.

Table 2 shows the dynamics in the village managers' decisions regarding water services and tariffs for their households. As a general trend, better water provision was introduced in all villages, and this was accompanied by and increase of water tariffs to be paid by local households. In some cases the increase in domestic water tariffs was perceived too high by local residents (village 3), affecting negatively their satisfaction index. On the other hand, the water tariff growth in village 3 triggered a huge improvement in the village manager's profit.

It was clear that the WUA gave priority to the domestic uses of water, not hampering any initiative of improvement of water provision by the local managers. The respect of an ecological reserve set at 500,000 cubic meters/year in years of drought and 750,000 in normal years was another WUA priority. Agricultural uses were more controlled and the release of new water licenses to farmers was less automatic, particularly when the dam reserve became scarce (last three year of the RPG session).

The water allocation policy by the WUA allowed positive results in terms of economic outputs for four farms out of five (cumulated profit). Cabbage was more profitable than citrus following a better trend in market price (apart from the final year). Particularly, farm 4 paid the cost of heavy investment in new hectares planted at citrus combined with lower market prices in years 3 and 4; in addition, the session was too short to allow the farmer recovering the investment through new citrus plants production.

	Initial	Final	Difference %
Irrigation scheme 1 (US)			
Ha citrus old technology	0	0	*0.0*
Ha citrus new technology	0	0	*0.0*
Ha cabbage	20	20	*0.0*
Cycles cabbage	2	3	*50.0*
Tot Ha	20	20	*0.0*
Employment (n)	51	77	*51.0*
Cumulated Profit (ZAR)	64,208	250,000	*289.4*
Irrigation scheme 2 (US)			
Ha citrus old technology	0	0	*0.0*
Ha citrus new technology	0	0	*0.0*
Ha cabbage	20	10	*-50.0*
Cycles cabbage	2	2	*0.0*
Tot Ha	20	10	*-50.0*
Employment (n)	51	25	*-51.0*
Cumulated Profit (ZAR)	64,208	250,000	*289.4*
Citrus farm 1 (MS)			
Ha citrus old technology	30	0	*-100.0*
Ha citrus new technology	0	5	_
Ha cabbage	0	30	_
Cycles cabbage	0	1	_
Tot Ha	30	35	*16.7*
Employment (n)	46	46	*0.0*
Cumulated Profit (ZAR)	829,300	3,290,000	*296.7*
Citrus farm 2 (MS)			
Ha citrus old technology	30	0	*-100.0*
Ha citrus new technology	0	30	_
Ha cabbage	0	30	_
Cycles cabbage	0	1	_
Tot Ha	30	60	*100.0*
Employment (n)	46	84	*82.6*
Cumulated Profit (ZAR)	829,300	740,000	*-10.8*
Citrus farm 3 (LS)			
Ha citrus old technology	40	0	*-100.0*
Ha citrus new technology	0	30	_
Ha cabbage	0	0	*0.0*
Cycles cabbage	0	0	*0.0*
Tot Ha	40	30	*-25.0*
Employment (n)	62	44	*-29.0*
Cumulated Profit (ZAR)	1,105,700	2,710,000	*145.1*

Table 2 – Strategies and outcomes for the five farms during the RPG session: initial and final values

	Initial	Final	Difference %
Village 1 (US)			
Population (hab.)	3,000	3,500	*16.7*
% river	0.8	0.0	*-80.0*
% collective tap	0.2	0.2	*0.0*
% indwelling tap	0.0	0.8	*80.0*
Water tariff (ZAR/m3)	1	2	*100.0*
Satisfaction index	40.6	41.7	*2.8*
Manager's cum. Profit (ZAR)	20,500	420,000	*1,948.8*
Village 2 (MS)			
Population (hab.)	5,000	5,500	*10.0*
% river	0.8	0	*-80.0*
% collective tap	0.2	0.2	*0.0*
% indwelling tap	0	0.8	*80.0*
Water tariff (ZAR/m3)	1	1.7	*70.0*
Satisfaction index	40.6	42.9	*5.7*
Manager's cum. Profit (ZAR)	34,180	300,000	*777.7*
Village 3 (LS)			
Population (hab.)	15,000	16,000	*6.7*
% river	0.1	0	*-10.0*
% collective tap	0.4	0	*-40.0*
% indwelling tap	0.5	1	*50.0*
Water tariff (ZAR/m3)	1.5	2	*33.3*
Satisfaction index	42.7	41.9	*-1.8*
Manager's cum. Profit (ZAR)	128,130	2,110,000	*1,546.8*

Table 3 – Strategies and outcomes for the three villages during the RPG session: initial and final values

Job creation was positive for some farms and negative for other. Employment is a cost for the farmer, who does not have it as a "social goal". Individual strategies aim at improving economic outputs, whereas social objectives, such as job creation in the catchment should be pursued by the local authorities.

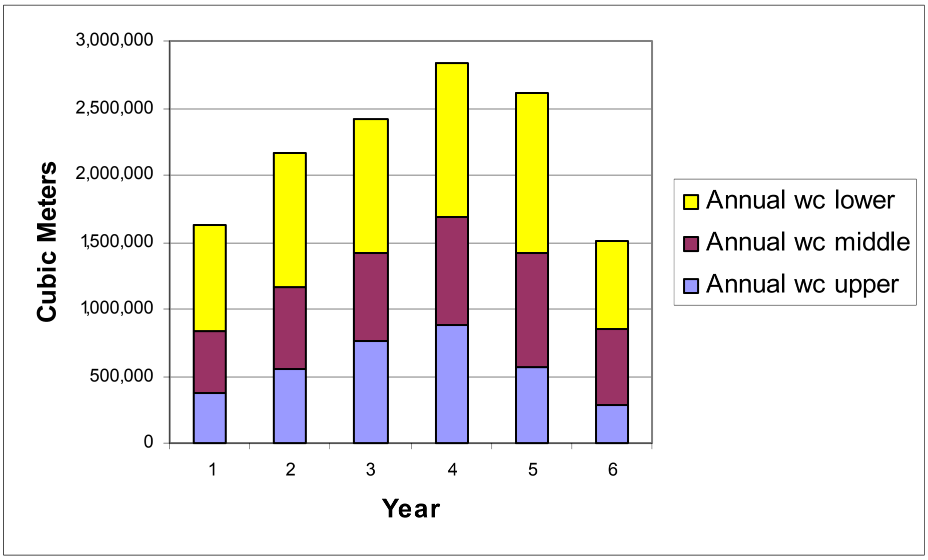

Figure 4 – Water consumption in the three sub-catchments

Figure 4 shows the dynamics of water consumption in the three sub catchments. At year 1 LS is the most water consuming (large village and large citrus farm) followed by MS and US. Le latter increases consistently water consumption during years 2 to 4 due mainly to the intensification of cabbage production. The slight increase in water consumption in the remaining sub catchments is due to domestic better provision and population increase. At year 5, water consumption in US contracted due to a change of strategy in one of the two irrigation schemes. At year 6 the WUA decided to stop releasing water from the dam in order to allow refilling.

Figures 5-7 show the dynamics of water consumption (red line) and water remaining in the river after consumption in the three sub-catchments during the session.

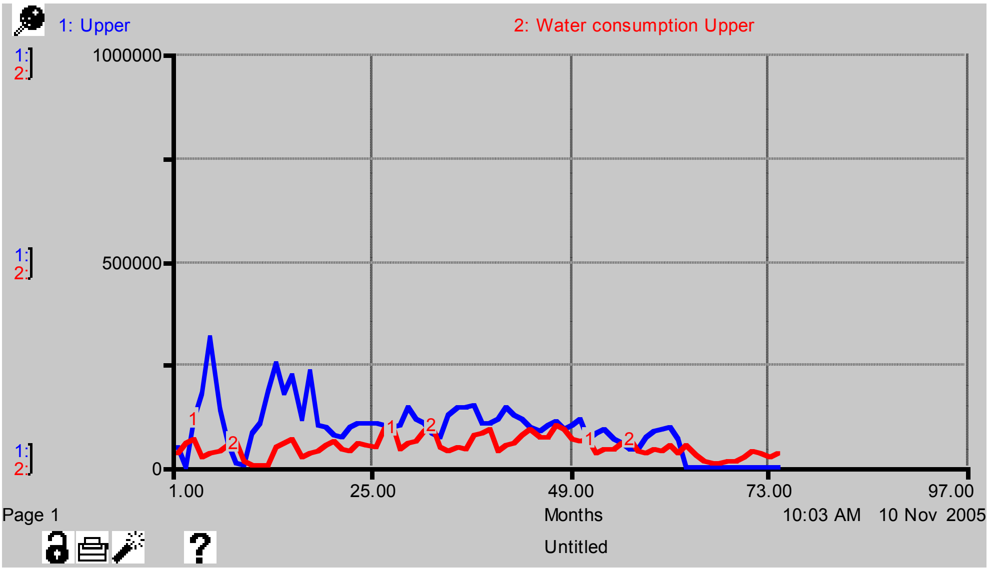

Figure 5 – Monthly water consumption (red line) and water flowing in the river after consumption: Upper Sub catchment

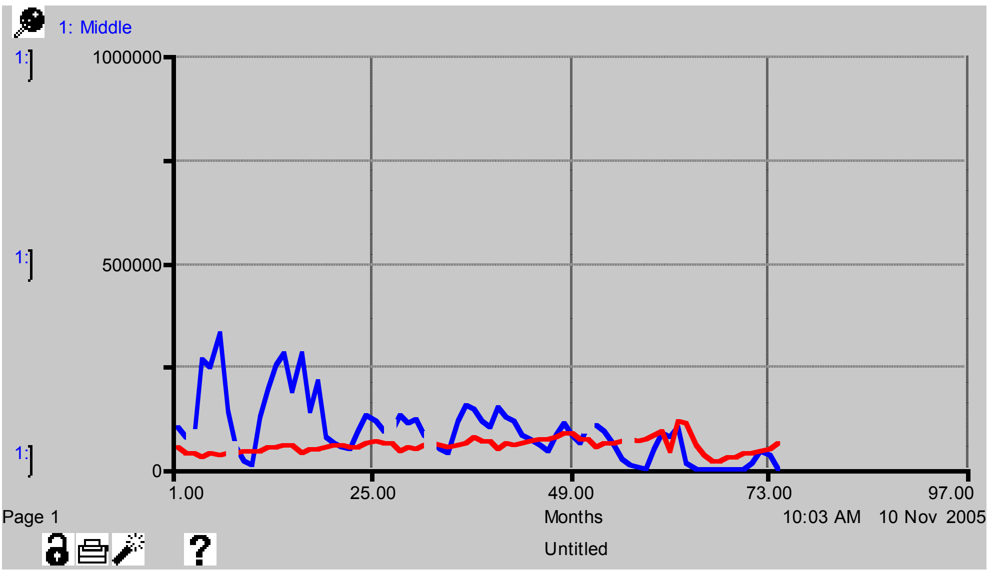

Figure 6 – Monthly water consumption (red line) and water flowing in the river after consumption: Middle Sub catchment

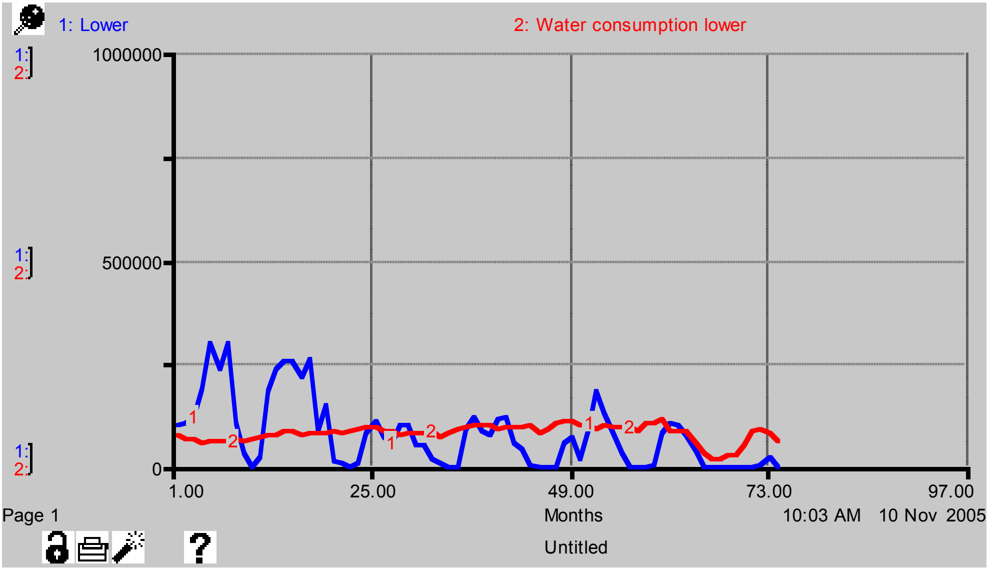

Figure 7 – Monthly water consumption (red line) and water flowing in the river after consumption: Lower Sub catchment

The trend in water consumption is increasing in the three sub-catchments over the first 4 years of the session, determining a growing stress in the MS and particularly in the LS (no water flowing in the river during some months). Cyclical consumptions due to annual crops are visible in the US, whilst more regular demands due to domestic uses and citrus production are identifiable in the MS and LS.

The increasing water demand in the three sub-catchments is partially compensated by water releases from the Dam decided by the WUA. Figure 8 indicates the water level in the Dam. WUA opted for a use of the water in the Dam to satisfy users' water demand and to provide a water flow in the river able to preserve ecological equilibriums (the ecological Reserve).

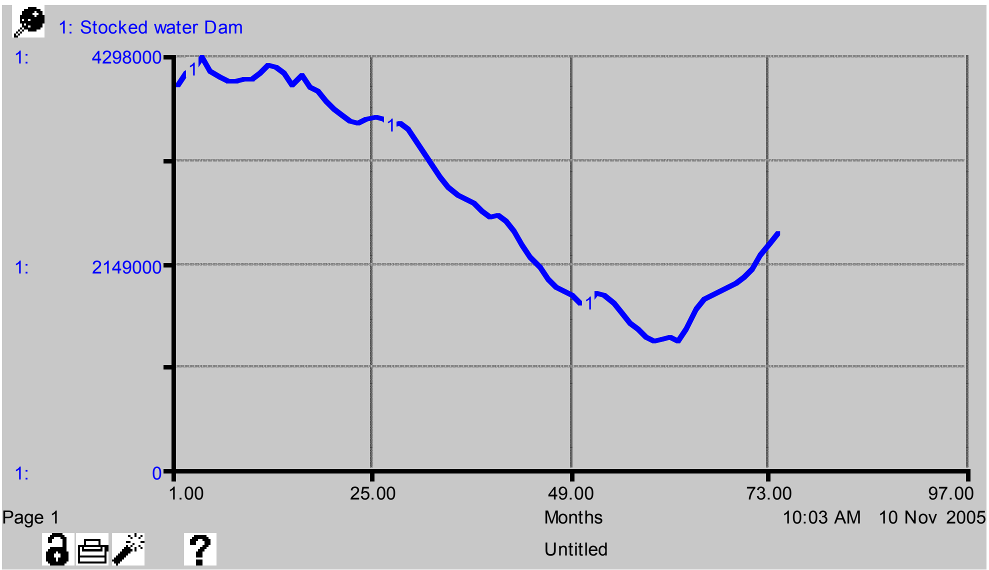

Fig. 8 – Dam level

At the end of year 5, when the Dam level reaches almost 1 million cubic meters, the WUA decided to stop suddenly and completely water flashes. This decision determined an improvement of the dam water quantity, but had an immediate and dramatic consequence on the socio-economic and environmental indicators in the catchment.

Figures 9 and 10 show the impact of water uses and management on profit and employment in the three sub-catchments.

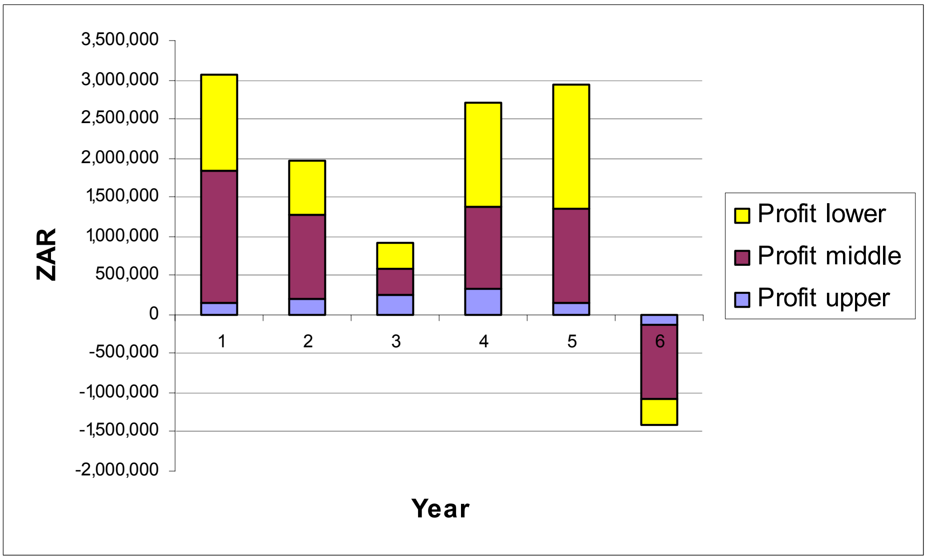

Figure 9 – Profit generation in the three sub-catchments

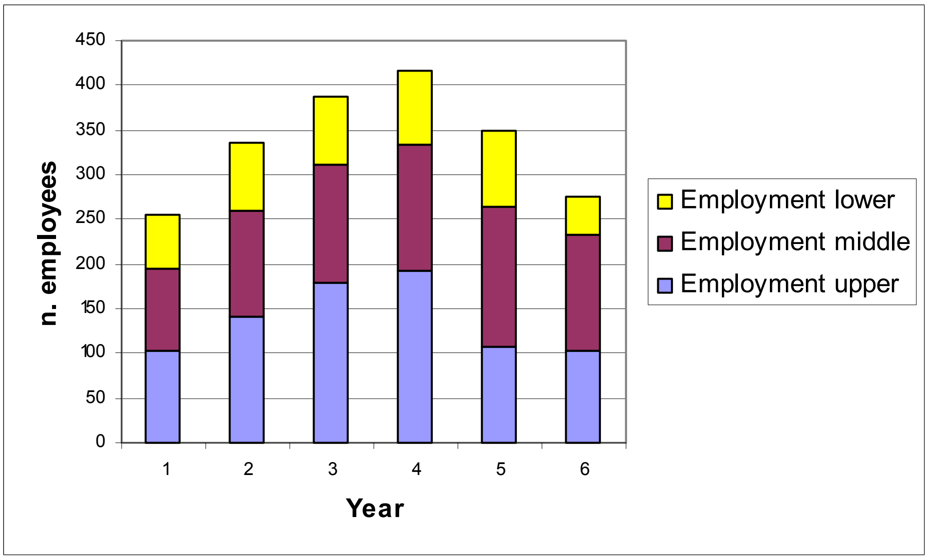

Figure 10 – Job creation in the three sub-catchments

Job creation is linked to the surfaces cropped and to the intensity of production (cycles of cabbages on the same surface); it therefore follows the dynamics of water consumption. Profit is more sensitive to water availability and during the first years of game is (negatively) influenced by high investments in the citrus farms[1]. Figure 9 shows clearly the heavy impact on profit generation for the three sub catchments of the WUA decision at year 6. Again, MS and LS where citrus farms are located suffer particularly for the water shortage.

It is worthwhile noticing, finally, that the decision to stop completely water flushes from the dam had a negative impact also on the ecological reserve.

[1] In this game, profit=total income-total costs. If a farmer invests in citrus plantations, therefore, his annual income during the first years of new orchards is constant (no production) whilst the costs increase. It was noticed by citrus farmers during the game debriefing that this is not really how they see things because an investment is calculated as a positive asset in their budget, whereas here is a negative (cost) one. They suggested calling “cash-flow” what we call “profit” in the game outcomes.

4. CONCLUSION AND WAY FORWARD

The RPG KatAWARE was played for a first session with the Kat River WUA in November 2005. A second session is scheduled for March 2006. A following work back to the KatAWARE model is then foreseen. Apart from the mentioned objectives of improving WUA's capacity of negotiation and common-decision-making (cf. Burt et al, 2005b), this will allow modellers introducing into the next version of the model (V2) that information about stakeholders' behaviour and practices derived from observation during the two game sessions. It is possible, but not sure, that a final session of the RPG will be played with the WUA after the presentation and discussion of the model's V2.

A use of the RPG in a modified and simplified version as a pedagogic tool (e.g. for university students) is also envisaged.

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